

of an aseptic film surface). Nothing in the '419 patent indicates to one of ordinary skill in the art the desire for a layer delamination.

The acceptable level of adhesion would also have been understood by one of ordinary skill in the art to be represented by a lack of interfacial failure between any two layers where no separation was desired during the use cycle of the packaging film. Therefore one of ordinary skill in the art would always have been motivated by a need to insure the adhesion between any two layers in a coextruded multilayer film. Interlayer adhesion could have been affected by orientation due to the stresses found during orientation and oriented films would have generally required affirmative steps to have been taken to insure interlayer adhesion such as using an adhesive resin between polymers which were known to have poor adhesion and that polymers which were compatible would not have needed an extra adhesive layer to bind them together.

It was also well known to those of ordinary skill in the art that polymers would not generally stick or adhere to each other and that there must generally be a means of enhancing the adhesion between polymer layers to prevent the delamination of the composite or coextruded film (Hessenbruch, p 87). When laminating this could have been an oxidation process, the use of special primers, or adhesive polymers and when coextruding it was well known that there must have been an adhesion promoting (or "tie") layer added to the structure between the incompatible polymers such as EVOH and LDPE (polyolefins in general) (Blackwell p 210). Thus when a polymer layer combination was presented where incompatible polymers were listed (e.g. LDPE / Nylon or LDPE / EVOH) it would have been understood by one of ordinary skill in the art that a tie layer was understood. There are however, to one of ordinary skill in the art, some well known exceptions such as between Nylon and EVOH, where the interfacial adhesion is strong due to the chemical nature of each polymer and the inherent polarity of each polymer so that no additional "tie" layer is needed (Blackwell, p 210, Journal of Commerce). Thus when Nylon/EVOH is presented it would have been generally understood by one of ordinary skill in the art that no tie layer may be intended or generally required.

Barrier materials

Barrier polymers were well known to those of ordinary skill in the art and it was understood that the level of barrier is controlled by the barrier polymer selected (Table 1 of Blackwell). The most widely used extrudable barrier polymers being polyacrylonitrile (PAN), polyvinylidene chloride (PVDC or Saran®), Nylons (Nylon 6, Nylon 66 as well as Nylon 6/66 blends and other nylon polymers) and polyethylene vinyl alcohol copolymer, (EVOH). It was also well known that some barrier resins could have been sensitive to and could have been negatively impacted by the environment of the barrier polymer. In particular it was known that the oxygen barrier of EVOH was sensitive to moisture level (figure 2 of Blackwell) and that the oxygen barrier of nylon was poorer than EVOH but less sensitive to moisture than EVOH so that at high humidity it was possible to have better oxygen barrier with some nylons than with EVOH (figure 3 of Blackwell), that PAN supplied an oxygen barrier and that PVDC supplied both moisture and oxygen barrier and was resistant to moisture effects. It was also well known to those of ordinary skill in the art that the high barrier polymers such as EVOH should have been protected from moisture gain by covering them with moisture barrier polymers such as polyolefins (figure 3 of Blackwell) like polypropylene, oriented polypropylene, polyethylene (HDPE, LDPE, LLDPE) and polyethylene blends (Blackwell p 210 Paragraph 1). In addition, it was known that the use

of nylon in direct contact combinations with EVOH would aid in preventing moisture absorption by EVOH (Journal of Commerce).

In addition to oxygen barrier, it was well known to those of ordinary skill in the art, that flavor and aroma barriers of polymers were very important for perishable food products and that both Nylon and EVOH added significant flavor, aroma, grease and oil resistance (Blackwell p 214, Hatley article, Journal of Commerce article) to coextruded packaging films (Blackwell p 214, Journal of Commerce) and that nylon and EVOH could have been used in combination to improve the flavor, aroma and odors and the cost effectiveness of barrier packaging (Journal of Commerce article).

Packaging Design Considerations

In designing packaging films at least the following film attributes would have been important:

1. **Packaging machine performance**
 - a) lay flat (curl)
 - b) coefficient of friction (COF)
2. **Appearance**
 - a) haze
 - b) clarity
 - c) gloss
 - d) package appearance (wrinkles, skin tight)
3. **Durability**
 - a) resistance to delamination of layers
 - b) flexibility i.e. resistance to pin hole formation in layers
 - c) abrasion resistance

 - d) puncture resistance
4. **Sealability**
 - a) seal range
 - b) seal strength
 - c) hot tack

- d) seal thru contaminants (grease, blood, dust) and gusset, wrinkled or pleating film
- 5. Printability
- 6. Barrier
 - a) moisture
 - b) oxygen
 - c) chemical (flavor and aroma)
 - d) light
- 7. Dimensional stability
- 8. Cost
 - a) material substitutions & combinations
 - b) process economics
 - c) thinner layers by orientation: appropriate thickness

While all these were and are still important film properties and attributes for packaging films, various products would not have required all of them or required that all of them have been present at their highest levels. This is because all packaged products are different and the chain of use or distribution and manufacturing operations are all different. Therefore it was necessary for the film designer of ordinary skill in the art to have been able to tailor the actual level of properties for each packaged product or product type, and this can only be determined from knowledge of the product's failure mechanisms and the desired shelf life, or time period for which the packaging protection is needed. A person of ordinary skill in the art would have known how or where to obtain this information such that the proper level of protection (moisture, oxygen, flavor and aroma barrier) could have been determined and the appropriate barrier materials and polymer material layer combinations could have been made. This is also true for packaging machine performance as each type and manufacture of packaging machine would have different film requirements for successful package formation.

1. Packaging machine performance

A person of ordinary skill in the art would have known how to modify film surfaces and select and combine polymer layers to permit acceptable bag formation on a variety of packaging machines or would have understood what the formulation and testing requirements were to determine the optimum film properties for successful packaging machine operation.

a) lay flat (curl)

Films that curl will create difficulties in transporting the film through both the film manufacturing and in packaging operations; therefore it would have been desired to have packaging films which lay flat when unwound. On packaging machines film curl causes the film to roll away from sealing bars, to wrinkle, or to catch on various surfaces or transition points in the packaging machine which could have caused a jam or interruption in the packaging operation. This would have required higher film tensions, required machine modifications or adjustments or simply failed to perform on the machine or lowered the productivity of the packaging operation.

It was well known to those of ordinary skill in the art that multilayer coextruded structures which did not have identical compositions and thicknesses around the film center line were prone to curl due to layer dimensional changes as from differences in resin density, due to post crystallization, variations in layer moisture absorption, layer stiffness, etc. For instance it was well known that A/B/C films containing nylon 6 (C) layers attached to a polyethylene (A) layer were prone to curl and that this interfered with the film's ability to be formed into pouches (Sneller, p 40, Hessenbruch, p 87) and that films with A/B/C/B/A structure were curl resistant and could have used less expensive materials (Sneller, p 40, Hessenbruch, p 87).

b) coefficient of friction (COF)

In packaging machines the films must be pulled (or pushed) through the packaging machine with a force which was low enough to prevent film breaks or tears, film scratching, film wrinkles and without excess noise. The force required to pull (or push) the film was controlled by the surface tractions between the film and the surfaces of the packaging machine. These tractions were controlled by the coefficient of friction or COF.

Typical variations in product design to impact COF would have been the polymer type and thickness for each surface of the film, the outer and inner layer formulation in terms of type and concentrations of additives such as antiblock particles and migratory additives, melting points of surface polymers. Both film to film and film to metal COF would have been important in terms of packaging machine operation and the ability to open or separate film layers (antiblocking) film as well as the ability to collate packages into additional packaging or cartons as well as to permit package stacking or indexing together without subsequent movement. Thus it would have been understood to one of ordinary skill in the art that differential film surface formulations were important differentiating characteristics of a film which would be controlled by film formulation in terms of concentrations of slip and antiblock additives. Differential COF behavior depends on differential film layer compositions as well as construction and it would have been known to one of ordinary skill in the art that differential surface behaviors were due to different skin compositions and that antiblock and slip levels constitute a real and significant difference over and above the general resin composition. Therefore it would have been obvious to one of ordinary skill in the art to describe two different surface layer compositions for the purpose of COF control to be two different and distinct formulations.

2. Appearance

Film appearance is important in the packaging of perishable food products because consumers often times need or want to view the food product to perceive its acceptability for purchase. It was well known to those of ordinary skill in the art that polymer selection and interfacial bonding would have affected the appearance of the film and printing which was applied to the package. In general many aspects of the film appearance were improved by orientation of the film. As the polymer layers are molecularly oriented, internal light scattering is reduced and the film becomes more transparent (US Patent 4,511,610, col. 7, lines 49 – 66), in addition the film surface was smoothed during stretching creating a smoother surface which would have enhanced film gloss, orientation also imparted heat shrinkability (US Patent 4,572,854, col. 7, 1143-53, US Patent 4,532,189, col. 1, lines 49-55) which when activated created tightly wrapped products improving the visibility of packaged products.

a) haze

Any material or additive which causes an increase in light scattering either at the film surface(s) or within the body of the film would have impacted the haze of the film and diminished or changed the appearance of the packaged product. Increasing haze reduced the amount of light arriving from the packaged product to the consumers' eye or lowered the contrast of the product features making the product more difficult to discern.

It was known that haze was impacted by film orientation due to the reduction in light scattering at the interface between polymer crystals and the unoriented polymer phase (in semicrystalline polymers such as polyethylene, polypropylene, nylon, EVOH, adhesive polymers). On orientation, the non crystalline polymer phase was aligned in the direction of applied stress and the chains were brought "closer" together, increasing the average phase density and lowering the density difference between the oriented phase and the crystals. This lower density difference resulted in less light scattering at the crystal/oriented phase boundary scattering less light and lowered the film haze and improving the film optical properties.

b) clarity

Clarity is the ability to see an object without excessive physical or color distortion when looking through the film.

It is often times desirable to have films of high clarity such that the packaged product is plainly visible without distortion. Therefore for multilayer films it was desired to have films with no layer delamination which would have induced additional film surfaces for light reflection interfering with the view of the packaged product. Also it was desired to have smooth and uniform interlayer joints so that light passing thru the film was not distorted making it difficult to clearly and distinctly view the product.

It was well known to one of ordinary skill in the art that materials, orientation, interface quality, additive levels and type, interface adhesion would all have effected film clarity.

c) gloss

Gloss is a measure of the film's surface reflectance and is related to the smoothness of the film surface.

It may also have been desirable to have a high gloss film to present an eye catching pleasing high quality appearance to the product. Film gloss was impacted by surface polymers used, film formulation as well as level of orientation. Oriented films would have tended to have a flatter, smoother surface which gave a better reflection and it was well known in the art that film gloss was controlled by film surface smoothness. However smoother film surfaces were more difficult to move thru packaging machines and additives were added to films to roughen the surface to improve film COF and machinability. The balance between film roughness and surface gloss was a key factor in developing a film which is fit for use.

It was well known to one of ordinary skill in the art that surface materials, orientation, additive types and level, and process conditions all would have impacted the film COF.

d) package appearance

In packaging with flexible films, it was oftentimes desired to have a tightly fitting or snug packaging layer to improve the product appearance, hold loose materials and liquids in place and to be free of wrinkles which could have detracted from the overall package appearance or have been a source of package snagging and ripping of the film layer during processing or in use at the point of sale. Consequently, in many packaging applications where a product is over wrapped it was desirable to have some level of shrinkage in the film so that the package could have been heated briefly and the film would shrink to tightly conform to the product. This was especially desirable when the product was of an unusual shape or if there were loose parts associated with the product. Also, a tight appearance improved the visibility of the product by removing the air space from between the film (contact clarity) and the product minimizing reflections etc which would have detracted from the view of the product and any effect of film haze. It was well known to those of ordinary skill in the art that film shrinkage could have been obtained by heating a film with some level of residual molecular orientation. As the film was heated the polymer chains became mobile and tried to release any orientation which was holding the molecules in a preferred direction. Therefore a way of measuring orientation levels was to measure film shrinkage at a temperature above the polymers softening point but below its melting point. This was called the free shrinkage and was typically related to the level of orientation in the film if it had not been reduced by annealing the film during manufacture to improve its dimensional stability. Thus it was possible to heat an oriented film and greatly reduce its ability to shrink by additional crystallization of the film or by stress relaxation of the film.

During film heating it was also possible to hold the film at a fixed length and in this instance the film would have developed a retractive force which would have attempted to pull the film ends together and this was termed the shrink energy or shrink force. The level of shrink energy would have been dependent on the polymer used, the temperature reached and the level of residual orientation in the film. High shrink forces would be desired if the film was to be used to help close a package or hold a flap in place during wrapping as well as to hold or bundle the product

together to prevent pilferage or product loss during package handling. Shrink force measurements were also used to measure the existence of residual molecular orientation.

3. Durability

A film's durability is the resistance of the film to damage which compromises its performance in a packaging application. This would have been recognized by one of ordinary skill in the art to represent overall package appearance, film cracking and pin-hole formation, barrier stability, and layer delamination during handling, etc. The film durability was oftentimes tested using the Gelbo Flex where the film was subjected to a controlled twisting and crushing action. The sensitivity of a film property, such as its oxygen barrier, would be measured by measuring the oxygen barrier (or other film attributes of interest), after a specific number of Gelbo Flexes. Various film materials were known by one of ordinary skill in the art to be sensitive to this flexing where pin holes or cracks and physical leaks could have been formed in the film with few flexes while other film materials were very resistant to the flexing.

It was also understood by one of ordinary skill in the art that EVOH was brittle and therefore sensitive to mechanical failures such as pin holes and flex cracks (Journal of Commerce article, US Patent 4,608,286 col. 3, lines 38-41, EP 0 063006 A1, p 1) which negatively impacts its barrier properties. It was also well known to those of ordinary skill in the art that the attachment of a layer of nylon directly to the EVOH would have improved the durability and flex crack resistance of the EVOH (Journal of Commerce article, EP 0 063006 A1, p 1), that the blending of Nylon into EVOH would have improved EVOH durability without negatively affecting the EVOH barrier properties (EP 0 063006 A1, p 19, US Patent 4,572,854, col. 4, lines 38-52), that the addition of polyolefin outer layers when combined with a tie layer between the polyolefin outer layer and the EVOH would have improved durability of EVOH layers to flex crack (US Pat '286, col. 5 l. 63 – col. 6 l. 8). In addition, it was also well known to those of ordinary skill in the art that the molecular orientation of the combined nylon/EVOH/nylon layers would further improve the durability of the composite film. (US Pat 4,640,852, col. 3 l. 60 – col. 4 l. 3.)

It was also well known by those of ordinary skill in the art that nylons and polyolefins were very durable when flexed.

a) resistance to delamination of layers

Delamination of layers occurs when the adhesion of two adjacent layers is insufficient to keep them in intimate or direct surface contact during the use of the packaging film. If the adhesion between two layer surfaces is too low, then the forces transmitted to the surfaces by flexing, bending or other handling of the film will cause the layers to separate. Layer adhesion is controlled by the chemical compatibility of the polymers in the two layers. For instance the differences in polymer polarity and chemical structure will control the attraction of the polymers together. In general polar and non-polar polymers will not adhere adequately to each other, while two polar (or two non-polar) polymers might form an acceptable bond. If the polymers are incompatible or form an unacceptable strength bond, a tie layer will be required to adhere them together to prevent delamination.

Film layer delamination was undesirable because it represented a failure of the film which could have affected its packaging performance and its appearance. If a delamination occurred it was reasonable to suspect that the package's protection could have been compromised and the consumer would have rejected the product. At the very least, a layer delamination would have affected the package's visual appearance, its optical properties and created wrinkles. If the layer delamination occurred between a thin barrier layer and another layer it was possible that the barrier layer itself might have been torn or broken which would have destroyed the barrier protection it was meant to supply. For this and other reasons, it was known that layer delamination was to be avoided as delaminated layers could have created thin layers which could be easily torn in handling of the package or in automated packaging equipment creating lower packaging productivity or package failures.

b) flexibility

During handling of the film and in forming a package, the film could have been pulled over small diameter radius forming collars or once in package form it could have been creased, folded, crushed, crumpled or distorted. This was often time simulated by a twisting, crushing test called the Gelbo Flex and was used to measure the film's resistance to cracking or forming holes in the polymer or delamination. Different polymers have varying resistance to this "pin holing" behavior which created direct leaks in the film or film layer which dramatically lowered the barrier performance of the film product.

For instance EVOH and polyester films and layers were well known to one of ordinary skill in the art to have poor resistance to pin hole formation on flexing while nylons and polyethylene and other polyolefins were known to have excellent resistance to pin hole formation.

It would also have been well known to one of ordinary skill in the art that adhering layers of the more durable materials to the surfaces of the less durable polymers could dramatically improve the pin hole resistance of the less durable polymer. Also that supporting the less durable polymer on both of its surfaces was effective (US Patent 4,608,286, col. 3, lines 55-62).

c) abrasion resistance

Abrasion resistance is the film surface's ability to resist scratching and scuffing when rubbed together or against metal surfaces of packaging machines giving the film a shop worn appearance and interfering with the film's clarity and haze levels. In general it would have been known of one of ordinary skill in the art that the scuff resistance was determined by the surface polymer selection and the addition of surface slip and antiblock additives which were used to lubricate film and machine surfaces or to reduce surface contact (and therefore COF) between film to film and film to machine surfaces as with the antiblock particles.

d) puncture resistance

Puncture resistance is important because it serves to protect the loss of film protection of a package due to handling, contact with sharp objects, consumer attack of the film etc. Puncture resistance is controlled by the strength and durability of the polymers in the film. Thus it would have been known to one of ordinary skill in the art that various materials had better puncture resistance than other materials.

One of ordinary skill in the art would have known it was possible to enhance or diminish durability by orientation and which materials benefited from orientation. In particular, it was known that EVOH was brittle and prone to damage by flexing and punctures while nylon, polyethylene vinyl acetate copolymers (EVA) and LLDPE as well as blends of EVA and polyolefins were good for puncture resistance and that the toughness of these materials could have been maintained or improved with orientation. Also, a person of ordinary skill in the art would have known that blending of nylon with EVOH would have improved durability and toughness of the EVOH/nylon blend.

4. Sealability

Sealability was added to a multilayer coextruded film by placing low melting thermoplastic layers on the outside sealing surfaces. In general, it was well known to one of ordinary skill in the art that sealability would be induced when the surface layer melts and flow together before the remainder of the film layers melt. Thus, it was known that sealability was determined by the relative melting point of a film surface layer relative to the remaining layers.

a) seal range

Seal range is the measure of the temperature interval between the point that an acceptable seal is formed (onset temperature) and the final temperature at which the film surface melts while forming an acceptable seal but does not shrink, melt or damage the other film layers. Seal range is important because it defines the machine parameters where a seal can be formed and ultimately the speed at which packaging can be performed when thermal sealing is required. One of ordinary skill in the art would have understood that a range of materials could have been used to form a sealable surface relative to the film inner layers and that melting points of the various materials would have been important in determining the acceptability of any particular material as a sealant in a layer combination.

b) seal strength

This is the measure of the force it takes to peel two sealed surfaces apart or the strength required to tear the film sample apart if the sealing surfaces do not peel. It is measured in gm/inch of width of sample tested and is generally measured at various temperatures to establish the seal range. One of ordinary skill in the art would have known that seal strength can be affected by material selection and sealant thickness as well as sealing temperature pressure and dwell time.

c) hot tack

Hot tack is the measure of a sealant surface's ability to maintain a form seal, while hot, so that when a stress is applied to the seal during the packaging operation the seal will hold together without opening. This is important in selecting sealing resins as this behavior will impact on the ultimate packaging speed which the film machine combination can be run at. As with seal strength a person of ordinary skill in the art would have known that the hot tack property would be dependent on the sealant material and temperature at which the seal was formed.

d) seal thru contaminants

The ability of a seal to be formed through contaminants such as dust, grease and blood is a feature of the sealant material chosen as well as the thickness of the sealant layer. Soft low melting, and polar sealants were known to one of ordinary skill in the art as being of special advantage in this regard such as the ionomer resins, the EVA resins, as well as LDPE and LLDPE, LMDPE and blends of the same as well as copolymer propylene. It was also known by one of ordinary skill in the art that the ability to seal folds and pleats was dependent on the thickness of the sealant such that the sealant can flow and "caulk" the area around folds and film edges.

5. Printability

In some instances the package surface is printed with regulatory indicia or other information such as use dates, product price as well as company logos and marketing information. In these instances the film needs to be printable and should give good adhesion to the printed information and have a glossy appearance.

6. Barrier

a) moisture

It was known to one of ordinary skill in the art that moisture barrier was important for some products to prevent moisture loss or gain and subsequent staling of the product. The known moisture barrier resins were the polyolefins which are "wax" like in their reaction to moisture and which exhibit a range of moisture protection generally related to polymer density. Moisture barriers were also known to be important when moisture sensitive barrier layers were used.

b) oxygen

It was known to one of ordinary skill in the art that an oxygen barrier was desirable for oxygen sensitive products and was supplied by the proper selection of the "barrier" polymer. It was well known to those of ordinary skill in the art that EVOH had the lowest oxygen permeability of extrudable polymers and that in some instances nylon, polyacrylonitrile or PVDC (Saran®) all were oxygen barrier resins.

c) chemical (flavor and aroma) barrier

It was well known to one of ordinary skill in the art that chemical or flavor and aroma barrier was desirable for taste sensitive products and was supplied by the proper selection of the "barrier" polymer. It was well known to those of ordinary skill in the art that EVOH, nylon, polyacrylonitrile or PVDC (Saran®) all could have been used as flavor barrier resins. This barrier property is a little more complex than oxygen because the optimum flavor barrier material will be dependent on the chemical nature of the flavor and the chemical resistance of the barrier polymer to the chemical of the flavor. It was known to one of ordinary skill in the art that optimum flavor and aroma protection was different for various polymers and when used in combination two or more flavor barriers would have been better than any individual polymer (Journal of Commerce article, Hatley article). This property alone would have provided

motivation to one of ordinary skill in the art to combine EVOH and nylon barrier layers together into a composite barrier.

d) light barrier

Light barrier supplies an additional protection to materials such as oils and fats which are susceptible to light induced degradation.

7. Dimensional stability

Dimensional stability is the measure of a film's change in shape when heated to or held at a specific temperature and is measured as a % change from the film's original dimensions at the heating temperature after some fixed time interval. It is generally associated with the shrinkage of the film. When a film is heated its dimensions will change due to the relaxation or thermal activation of the frozen in recoverable strain present in a film from molecular orientation of the polymer chains. The molecular orientation in the film is generally produced by melt or solid state orientation and in the case of shrink films the recoverable strains can be significant (for example 15% to 60%) in magnitude. In general films which display shrinkage indicate the presence of molecular orientation.

However, it is also possible to greatly diminish the shrinkage (recoverable strains) by annealing the film which is a heating process where the film dimensions are maintained or controlled so that film shrinkage is minimized. This results in a shrink force or energy being developed in the film as the molecular orientation is being reduced. Annealing can significantly reduce the potential shrinkage of a film and is used extensively with oriented packaging films to improve their resistance to temperature induced dimensional changes to improve their converting properties if desired. In these instances molecular orientation can be measured by the directional variation in other film properties such as the film's mechanical strength variations and other well known methods.

8. Cost

Cost of packaging films was always a driving force in development and improvement of packaging films as films are generally sold by the pound but packaging consumes them by the area. Therefore a thinner film or film layer would have been understood by one of ordinary skill in the art as being a less expensive film to produce due to material savings.

a) material substitutions & combinations

Resin cost was and is a large fraction of any film's economics and the use of substitute materials or material combinations which replaced more expensive materials with less expensive materials would have been sought and implemented by one of ordinary skill in the art. Also, any process which improved a film or film layer property would have been implemented because it would have permitted the use of a thinner layer to maintain the same level of packaging protection thereby reducing film cost. Nylon was known by those of ordinary skill in the art to be less expensive than EVOH and any use of nylon which reduced EVOH use or permitted the use of thinner EVOH layers by an improvement in EVOH properties would have been sought and implemented. In the same light orientation of EVOH was known to those of ordinary skill in the

art to improve EVOH barrier properties and would have been employed whenever possible to lower the cost (or improve the quality) of the film.

b) process economics

Coextrusion processes were well known to those of ordinary skill in the art and it was well known that coextrusion permitted the use of thinner polymer layers than other methods of film combinations. This is because in coextrusion no individual film layers must be produced and that the other film layers would support the individual layers and that the composite film strength would be a combination of the strengths of the individual layers. Therefore it was not necessary to produce a stand alone film layer which would have to be thicker than needed for the desired property just to be strong enough to be made and handled. This permitted the use of less material and in particular of the more expensive specialty materials which are not necessarily valued for their strength but some other attribute such as oxygen or aroma barrier.

It would have been known by one of ordinary skill in the art that the production of symmetrical structures could reduce the complexity and therefore equipment costs by minimizing the need for individual extruders for each layer.

c) thinner layers by orientation: appropriate thickness

As in coextrusion, orientation was well known to those of ordinary skill in the art and it was well known that most film or polymer properties could be enhanced by orientation. This is especially true of barrier and strength properties. Therefore it was known that after orientation the film layer thickness could have been reduced maintaining the same level of property. This use of thinner layers would have reduced the cost of the layer which was being reduced in thickness. Any loss in strength, stiffness or bulk obtained by reducing thickness could easily be offset by addition of a less expensive resin to replace the lost thickness, bulk and strength.

Oriented

As I indicate in other portions of this report some of the prior art references that I have reviewed do not specifically use the term "oriented" or specifically disclose oriented films. However, claim 11 of the '419 patent is directed to "oriented" films. Therefore for the purposes of this report, I will define what I believe "oriented" to mean in claim 11 of the '419 patent.

It was well understood by a person of ordinary skill in the art that the method of producing film would have affected its final property profile and that orientation would have improved most film properties such as physical, optical and barrier properties. It was also well understood by those of ordinary skill in the art that the level of molecular orientation would also impact the relative level of the various property improvements and that several means of orientation were possible and that it would have been generally very difficult to produce an extruded product with no inherent molecular orientation.

Molecular orientation could have been induced in one (uniaxial) or two (biaxial) directions in a film by draw down of a melt from a die, by inflation of a melt tube, by uniaxially stretching flat sheets by acceleration between rollers or with a tenter frame and could have been biaxially oriented either sequentially or simultaneously in a tenter frame or by inflation of a heated tube.

The term blown bubble (blown film) process ordinarily would have described to one of ordinary skill in the art the inflation of a melt tube while double bubble and tenter frame would have implied stretching from the solid state.

Examining the specification of the '419 patent, "oriented" is described in col. 3, lines 45-49:

"The term "oriented" and the like is used herein to define a polymeric material which has been heated and stretched to realign the molecular configuration, this stretching accomplished by a racking or blown bubble process."

In my opinion, this would mean, to one of ordinary skill in the art, that for the '419 patent "oriented" would include heating and stretching polymeric material to realign the molecular configuration accomplished by at least, "racking" and [melt] blown bubble process. The term "racking" is later at col. 3, lines 63-66, clearly defined as:

"The term "racking" is used herein to define a well-known process for stretching coextruded and reheated multilayer film by means of tenterframing or blown bubble processes."

In my opinion this would mean to one of ordinary skill in the art that for the '419 patent "racking" includes both tenterframe and [double] blown bubble processing from the solid state because in the description of "racking" it is clear that the multilayer film is "reheated" from the solid state as was practiced in the tenterframe and double blown bubble orientation processes.

Thus, combining the '419 patent's definition of "racking" with the '419 patent's definition of the term "oriented" it is my opinion that one of ordinary skill in the art would understand that in claim 11 of the '419 patent, "oriented" would include heating and stretching polymeric material to realign the molecular configuration accomplished by at least a {Tenter frame or [double] blown bubble} or [melt] blown bubble process.

Also present in the '419 specification is the preferred orientation heating temperature range. The preferred temperature range described clearly exceeds the melting point(s) of the surface layer polymer blend in Example 1; the '419 patent states in col. 8, lines 65-66:

"Preferably, films made in accordance with the present invention are heated to between about 90° C. and 140° C.,...."

According to current Dow Product literature, the melting points of the Dowlex 2045 and Dowlex 2037 (used in example 1) are 122 °C and 124 °C respectively and the melting points would not have been appreciably different in 1986 from the values found today. Nor would a person of ordinary skill in the art have expected that Dowlex 2045 and Dowlex 2037 would have melted above 140 °C because it was understood from the '419 specification that they were LLDPE's which were known to melt in a temperature range lower than high density polyethylene which melts at approximately 135 °C. Also, the melting point of the El Paso PE204-CS95 EVA copolymer (while currently unknown to me) would have been expected to melt below 110 °C due to its composition as a 17% vinyl acetate, 83% ethylene copolymer.

Therefore the '419 patent specification's stated, preferred orientation temperature range would have clearly permitted a stretching temperature which could have exceeded the melting point of

these particular polymer layers. It was typical of many stretching operations that particular film layers were above the layers melting point during the stretching operation and this would have been known to one of ordinary skill in the art.

Consequently, films of the '419 patent may well have contained both melt and solid state orientation both singly and in combination in various individual polymer layers and in my opinion are not limited to simply solid state orientation.

It is my understanding that the parties have not yet settled on claim constructions. Consequently, I do not know what meaning Cryovac will give to the term "oriented". Should Cryovac's definition of "oriented" be different than mine I may offer an opinion that claim 11 is invalid because it is my opinion that the specification does not allow for a different definition.

Arranged Symmetrically

Because the parties have not yet settled on claim constructions, I do not know what exact meaning Cryovac will give to the term "arranged symmetrically". However, it is my understanding that Cryovac's definition of "arranged symmetrically" may only require a similar composition for layer pairs without regards to the layer thickness of the film.

It is not my intention at this time to declare what the meaning of "arranged symmetrically" absolutely represents for the purposes of determining whether or not the Clearshield products infringe the '419 patent. But I will describe below how I will treat the term "arranged symmetrically" for the purposes of this validity argument.

The specification of the '419 patent does not specifically provide a definition of the term "arranged symmetrically" but does provide guidance to its meaning.

The description of the preferred embodiment describes the outer layers in col. 5, lines 24-48 and more particularly in col. 7, lines 44-47 which states, "Even more preferably, each of outer layers 16 and 18 comprise about 30% of the total thickness of the multilayer film of the invention."

It is clear that the materials of the outer layers are to be the same because in the description of the preferred embodiment it is stated in col. 5, lines 29, "This blend..." which is used to describe the outer layers 16 and 18 of figure 1, in col. 5, lines 23-24, "... outer layers 16 and 18 may comprise a blend..."

In example 1 col. 7, lines 27-32, is stated, "... the total wall thickness was about 14 mils, with about 55% of the structure comprising the outer blend layer, 20% of the structure comprising the intermediate polyamide layers, 15% comprising the adhesive layers, and 10% comprising the EVOH core layer." It is clear from this description that the pairs of outer, intermediate and adhesive layers are considered as equal as no special emphasis is made to describe them in differential terms.

Example 2 also describes layer structures and materials in reference to the method of example 1 and only substitutes different outer layer and adhesive compositions relative to example 1 and states in col. 8, lines 11-13, "...and the relative thickness of the various layers was substantially the same as in the sample film of example 1."

Inspecting Figure 1 there appears to no distinguishing features or differences between any of the various pairs of layers around the core layer and (while I understand that figures do not have to be drawn to scale) if the individual layers in Figure 1 are measured, each of the layer pairs arranged around the core are indeed of the same dimensions. Also, there is no discussion or mention of differential properties for the various layer pairs or a description which would teach that they were of different composition.

Indefiniteness And Lack of Written Description

Under my understanding of Cryovac's potential definition of "arranged symmetrically" which only requires a similar composition for layer pairs without regards to the layer thickness of the film, I find no support for Cryovac's definition in the written description. As described above, the only descriptions I find in the '419 patent are of films that have layers of equal thickness and composition. Consequently, it is my opinion that the inventor of the '419 patent has not described a film with unequal outer, adhesive or intermediate layers.

Furthermore, it is my opinion that one of ordinary skill in the art would not be able to determine what is a similar composition when trying to apply what I understand Cryovac's definition of "arranged symmetrically" to be. If for example that definition allows claim 11 to cover film that has the structure A/B/C/D/C/B/A, it is my opinion that there is no way for one of ordinary skill in the art to determine how similar A' and A must be in order to determine if there is infringement. For example, the '419 patent does talk about LLDPE and LMDPE but does not indicate whether or not all LLDPEs are similar to each other or whether or not LLDPE is similar to LMDPE. It was well known to those of ordinary skill in the art that the range of physical, thermal and sealing properties available for polymers such as LLDPE and LMDPE and their blends would have been affected by the choice of comonomer used in the polymerization of the LLDPE and LMDPE as well as the MI (melt index) of the polymers and that there were many grades of LLDPE and LMDPE available to the film designer. The density ranges for various polymers are quoted in the '419 specification. However, there are no teachings to guide one of ordinary skill in the art as to how to select from amongst the many available LLDPE and LMDPE polymer grades those polymer grades which alone or when blended together would have been considered similar in the final film product.

The '419 patent also describes the use of additives such as slip and anti block additives but also gives no guidance to one of ordinary skill in the art as to the importance of additives or different levels of such additives when attempting to determine if two layers are similar. A person of ordinary skill in the art would have understood that if differential slip, antiblocking, sealing, printing or packaging machine functions or behavior were important or desired, that the film surface layers 16 and 18 would have to have contained different layer compositions. These differential surface requirements would have required that the film layers 16 and 18 be sufficiently different in their compositions so as to render them different from each other.

Thus, if the definition of "arranged symmetrically" depends upon there being similar compositions, it is my opinion that the term is indefinite and that one of ordinary skill in the art could not determine the scope of claim 11.

Prior art

US Patent 4,746,562, "Packaging Film", Ennis M. Fant, Assignee W. R. Grace & Co., Cryovac Div, May 24, 1988.

1. An oriented

The 4,746,562 patent specifically discloses in col. 6, lines 1-4, "the film [...] is preferably not stretch oriented, and therefore preferably a non-shrinkable film, especially in applications such as vertical form-fill-seal packaging." which to one of ordinary skill in the art would represent that a film which was stretch oriented and heat shrinkable was possible but not preferred in this particular application.

The 4,746,562 patent recites in col. 5, line 15, "The materials are coextruded as a relatively thick tube or "tape" which has an initial diameter dependent on the diameter of the coextrusion die."

A person ordinarily skilled in the art would have understood that the term "relatively thick tube or "tape"" represented the extruded first bubble, cast tube or precursor tube which was later stretched to a larger diameter and reduced thickness. This understanding would have been based on the term "initial diameter" which implies the existence of a second or final diameter. The "tape" means that the tube has been collapsed into a flat configuration after solidification of the initial diameter tube. This collapsing of the first diameter tube is also described in the '562 patent specification in col. 3, lines 24-26, "..., extruding the 7 layer film from the coextrusion die; cooling the coextruded film; collapsing the cooled film;...". The solidified, collapsed tube or "tape" of the initial diameter means that the resulting film of the final diameter which is described relative to the initial diameter must have been made by stretching reheated film. "Relatively thick tube" implies or discloses the later formation of a thinner later stage which would imply or disclose an orientation or stretching of the initial tube into a second larger diameter and reduced thickness tube or film.

This stretching to a larger diameter was understood or further confirmed from the description of the film as having an initial diameter related to the coextrusion die which would have been understood by one of ordinary skill in the art to precede the second or final diameter of a tube of film obtained from molecularly orienting the film by an inflation either from the melt or from reheating and stretch orienting the initial tube. This inflation process results in an oriented film.

Furthermore the '562 patent recites in col. 6 lines 1-4; "The film of the present invention is preferably not stretch oriented, and therefore preferably a non-shrinkable film, especially in applications such as vertical form-fill-seal packaging" To one of ordinary skill in the art, stretch orientation meant a solid state orientation. The '562 patent specification simply expresses a preference for a non-shrinkable, non stretch oriented films for use in vertical form fill and seal packaging applications. However, other applications would not be limited to, or exclude the use of solid state oriented films and moreover would benefit from the use of stretch oriented films for improved physical, barrier, optical and shrinkage properties.

Therefore it is my opinion that one of ordinary skill in the art would have understood that the '562 patent disclosed the existence of stretch oriented films.

In the unlikely event that the court or jury determines that the '562 patent does not specifically disclose an "oriented" film, a person of ordinary skill would have been motivated to orient the film of the '562 patent to improve the barrier properties, to improve the mechanical, optical, shrink properties and to minimize the amount of materials consumed in the packaging of the perishable food product.

Therefore one of ordinary skill in the art would have been motivated to orient the film of the '562 patent. This motivation could have come from either the common knowledge of the advantages of orientation or the teachings of oriented film and its advantages as disclosed in prior art references or discussed in the section "The Obviousness of Orienting Multilayer Coextruded Films".

2. Coextruded film

The 4,746,562 patent recites in col. 5 line 15, "The materials are coextruded." Therefore the '562 patent specifically discloses a coextruded film.

3. Having at least 7 layers

The 4,746,562 patent recites in col. 5 lines 8-9, "For the preferred seven layer film", therefore the '562 patent specifically discloses a 7 layer film.

4. Arranged symmetrically

The 4,746,562 patent recites in col. 3 lines 66 to col. 4 line 4, "The film structure depicted in Fig. 1 is directed to a multilayer film which is preferably palindromic or symmetrical in construction. A film structure is directed to a multilayer film having the generalized structure of A/B/C/D/C/B/A where A is an outer layer, B is an adhesive layer, C is an intermediate layer and D is a barrier core layer."

The '562 patent recites in col. 5, lines 8-12, "for the preferred seven layer film having the two identical surface layers, two identical adhesive layers and two identical intermediate layers, and the core layer of ethylene vinyl alcohol copolymer,..."

Therefore the '562 patent specifically discloses a symmetrical 7 layer structure.

5. A core layer comprising an ethylene vinyl alcohol copolymer

The 4,746,562 patent recites in col. 4 lines 12-13, "Preferably, core layer 10 is an ethylene vinyl alcohol copolymer ...", therefore the '562 patent specifically discloses a core layer of ethylene vinyl alcohol copolymer.

6. Two intermediate layers each comprising a polyamide

The 4,746,562 patent recites in col. 4 lines 21-24, "Intermediate layers 12 and 14 are polyamides such as nylon 6. Various nylons are suitable in connection with the present invention including high viscosity versions and nylon copolymers", therefore the '562 patent specifically discloses nylon intermediate layers on both surfaces of the ethylene vinyl alcohol core.

7. Two outer layers each comprising a polymeric material or blend of polymeric materials.

The 4,746,562 patent recites in col. 4 lines 27-28, "Outer layers 16 and 18 comprise a linear low density polyethylene blended with an antiblocking agent." Linear low density polyethylene is a polymeric material.

Therefore, the '562 patent specifically discloses two outer layers each comprising a polymeric material.

8. Two layers, each comprising an adhesive material, which adhere each of said intermediate layers to a respective outer layer

The 4,746,562 patent recites in col. 3, line 68 to col. 4, line 3, "A film structure is directed to a multilayer film having the generalized structure of A/B/C/D/C/B/A where A is an outer layer, B is an adhesive layer, C is an intermediate layer...", therefore the '562 patent specifically discloses two adhesive layers located between the outer polymeric layers and the intermediate nylon layers.

Consequently, in my opinion all of the elements of claim 11 of the '419 patent are disclosed in the '562 patent. As noted above, while it is my opinion that the '562 patent discloses "oriented" film, in any event the subject matter of claim 11 of the '419 patent would have been obvious to one of ordinary skill in the art because there was motivation to orient the disclosed film.

Fant Film Sample

During the prosecution of the '419 patent, Cryovac disclosed that a film made in accordance with the teachings of the '562 patent was "tested at Richardson Foods (New York) and So-Pak-Co (South Carolina) for use in vertical form/fill/seal machinery as pouch material." I will refer to this as the Fant film.

The Fant film disclosed in the '419 patent prosecution has the structure:

90% LLDPE + 10% antiblock/LLDPE-based tie layer/nylon 6/EVOH/nylon 6/LLDPE-based tie layer/90% LLDPE + 10% antiblock.

Based upon Cryovac's disclosure that the Fant film was made in accordance with the '562 patent and based upon the structure of the Fant film one of ordinary skill in the art would have understood that it was produced by coextrusion.

The Fant film has all of the elements of claim 11 of the '419 patent with the exception that Cryovac claimed that the Fant film was unoriented.

While there was no definition of "unoriented" given for the Fant film, in my opinion, one of ordinary skill in the art would have understood that "unoriented" meant that the film properties would be perfectly uniform in all directions in the film. This is sometimes relaxed to mean at the very least uniform in the plane of the film.

In my opinion it would have been extremely difficult to produce an unoriented film. Thus, while the details will be revealed in discovery, I am skeptical that the film was in fact unoriented.

However, if the Court or jury should determine that the Fant film was unoriented there would have been sufficient motivation to one of ordinary skill in the art to have oriented the Fant film as discussed in the section entitled the obviousness of orienting multilayer coextruded films and therefore the subject matter of claim 11 of the '419 patent would have been obvious.

US Patent 5,055,355, "Oriented Film Laminates Of Polyamides and Ethylene Vinyl Alcohol Copolymers", Ferdinand A. DeAntonis, William H. Murrel, Alfieri Degrassi, Assignee Allied-Signal Inc., Oct 8 1991

1. An oriented

The 5,055,355 patent recites in col. 4, lines 10-14, "Preferably the film laminate is oriented to a draw ratio of from 1.5:1 to 4:1 in at least one direction. Preferred orientations include monoaxially oriented film laminates and biaxially oriented film laminates." Therefore the 5,055,355 patent specifically discloses an oriented film.

2. Coextruded film

The 5,055,355 patent recites in col. 2, lines 13-14, "The preferred film laminate is formed by coextrusion." Therefore the '355 patent specifically claims a coextruded film.

3. Having at least 7 layers

The 5,055,355 patent recites in col. 3, lines 46-52, "In addition to having at least one layer of polyamide adjacent to at least one layer of ethylene vinyl alcohol copolymer the film laminate of the present invention can include laminates and other polymeric film layers. Included in the other polymer film layers are polyolefins and polyolefin copolymers including ionic copolymers. Adhesive layers include modified polyolefins."

Reviewing claim elements 4, 5, 6, 7, and 8 defined below highlight the structure of the disclosed film.

Therefore the '355 patent specifically discloses a 7 layer structure where one of ordinary skill in the art would have understood the use of two layers of nylon attached to the two surfaces of the EVOH core and that the incorporation of additional polyolefin layers would have required the use of the disclosed tie layers to adhere the polyolefin layers to the nylon intermediate layers attached to the EVOH layer.

4. Arranged symmetrically

The 5,055,355 patent recites in col. 2, lines 19-21, "Structures which are particularly preferred are balanced or symmetrical structures to prevent curling of the film." Therefore the '355 patent specifically discloses the use of symmetrical film structures.